इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS 13134 (1992): Guide for the selection of insulators in respect of pollution conditions [ETD 6: Electrical Insulators and Accessories]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN
IGNORANTIA JURIS NON EXCUSAT
PROTECTED BY COPYRIGHT

IS 13134 : 1992

(Reaffirmed 2003)

भारतीय मानक

प्रदूषित अवस्थाओं स्वसंबंधित विद्युत रोधकों के चयन की मार्गदर्शिका

Indian Standard

GUIDE FOR THE SELECTION OF INSULATORS IN RESPECT OF POLLUTED CONDITIONS

UDC 621·315·62·001·37 (036)

© BIS 1992

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

February 1992

Price Group 5

Electrical Insulators and Accessories Sectional Committee, ETD 06

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Electrical Insulators and Accessories Sectional Committee had been approved by the Electrotechnical Division Council.

The performance of insulators in polluted conditions has been the subject of many studies that permit the specification of the required insulation when the site pollution is known, or by experience of insulator performance in the same region which has been operating at the same or at a different system voltage. The approach based on laboratory simulation of natural pollution consists consequently of the following steps:

a) evaluation of type and severity of the pollution at the site,

b) specification of a laboratory test as representative of the pollution of the site as possible (in particular *see* IS 8704 : 1978), and

c) selection of insulators which would show a good behaviour under this test.

This method of selection and specification of the required insulation should be adopted whenever circumstances permit.

Obviously, this approach has some limitations, for instance, when a natural site cannot be represented in a satisfactory way by an artificial pollution test in the laboratory.

The aim of the present guide is to give, on the basis of the experience in service and numerous test results in naturally and artificially polluted conditions, *simple general rules that should assist in choosing the insulator which should give satisfactory performance under polluted conditions.*

These guidelines are essentially based upon *minimum creepage* distance requirements associated with a few other geometrical parameters, which generally do not limit the design of the insulator itself. They provide an easily accomplished way to choose insulators based on the predicted severity of the site where these insulators are to be installed. The above requirements are based on insulators having an acceptable risk of flashover when operating under such polluted conditions.

NOTE — Suitable testing carried out in the laboratory or direct experience obtained in natural conditions may allow the minimum creepage distances specified in this guide to be reduced (for instance, for insulators specially designed for polluted conditions).

This guide describes the method of insulator selection by:

a) evaluating qualitatively the severity of the pollution of the site (*see* **4**, Table 1 and Annex A); and

b) choosing insulator dimensions with regard to the minimum specific creepage distance (Table 2) within the limits stated in **5**.

In special cases, washing or greasing of insulators can be used (*see* Annex B).

This guide also indicates, by way of information:

Different methods for measuring the pollution severity that make it possible to check, or to know with greater accuracy, the actual pollution severity of a site, while bearing in mind that valid information often calls for several years of measurements (*see* 7); and

Relation between pollution levels and artificial pollution tests (*see* Annex C).

This guide is based on IEC Report 815-1986 'Guide for the selection of insulators in respect of polluted conditions', issued by the International Electrotechnical Commission.

Indian Standards

GUIDE FOR THE SELECTION OF INSULATORS IN RESPECT OF POLLUTED CONDITIONS

1 SCOPE

1.1 This guide is mainly applicable to three-phase systems up to 52·5 kV (phase-to-phase). For higher voltages, the possible non-linear performance of insulators is still under study.

1.2 This guide is applicable to outdoor ceramic and glass insulators used in ac systems, of the following types:

a) Long-rod and traction line insulator,
b) Cap and pin insulator,
c) Pedestal type post and rigid pin insulator,
d) Substation and line post insulator,
e) Hollow insulator, and
f) Bushing.

1.3 This guide cannot directly be used for special types of insulators such as insulators with conductive glaze, or covered, during the manufacturing, with any insulating material, for surge arresters and also for longitudinal insulation for open circuit-breakers. This guide does not deal with radio interference voltage, television interference voltage and audible noise, the intensity of which may be increased on some polluted insulators.

2 REFERENCES

2.1 The following Indian Standards have been referred and are necessary adjuncts to this standard:

IS No.	*Title*
1885 (Part 54) : 1980	Electrotechnical vocabulary : Part 54 Insulators
8704 : 1978	Method for artificial pollution tests on high voltage insulators for use on ac systems
2165 : (in various parts)	Insulation co-ordination

3 TERMINOLOGY

3.1 The definitions of terms relating to insulators covered in IS 1885 (Part 54) : 1980 shall apply.

4 POLLUTION SEVERITY LEVELS

4.1 For the purposes of standardization, four levels of pollution are qualitatively defined, from light pollution to very heavy pollution.

4.1.1 Table 1 gives, for each level of pollution, an approximate description of some typical corresponding environments. Other extreme environmental conditions exist which merit further consideration, for example, snow and ice in heavy pollution, heavy rain, arid areas.

5 RELATION BETWEEN THE POLLUTION LEVEL AND THE SPECIFIC CREEPAGE DISTANCE

5.1 For each level of pollution described in Table 1, the corresponding minimum specific creepage distance, in millimeters per kilovolt (phase-to-phase) of the highest voltage for equipment is given in Table 2.

5.2 Experience has shown that the criterion of 'minimum specific creepage distance', which implies linearity under pollution between withstand voltage and creepage distance, applies to most insulators used on existing systems.

5.3 Some insulators specially shaped for particular kinds of pollution may not satisfy these conditions even though they perform satisfactorily in service.

6 APPLICATION OF THE SPECIFIC CREEPAGE DISTANCE CONCEPT

6.0 General

In order to successfully apply the *specific creepage distance* concept, certain dimensional parameters characterizing the insulator shall be taken into account.

6.0.1 These parameters, based on service experience and on laboratory tests, mainly relate to the shed shape or to the profile of the insulator, but also to the diameter and the position in service of the insulator.

6.0.2 The parameters given in **6.1** to **6.3** are not intended to limit the future development of insulator design. They simply recommend certain limits (indicated in Annex D) which must be interpreted flexibly in order to provide a high probability of satisfactory performance in service.

6.1 Parameters Characterizing the Profile (*see* Annex D)

6.1.1 The profile of an insulator is characterized by the following parameters:

a) Minimum distance, c, between sheds;
b) Ratio s/p between spacing and shed overhang;
c) Ratio l_a/d between creepage distance and clearance;
d) Alternative sheds [*see* Fig. 2 and Fig. 3b)];
e) Inclination of sheds; and
f) Parameters characterizing the entire insulator:
    i) creepage factor (C.F.), and
    ii) profile factor (P.F.).

Table 1 Pollution Levels

[*Foreword, Clauses* 4.1.1 *and* 8.1.1 (a)]

Pollution Level	Examples of Typical Environments
I — Light	Areas without industries and with low density of houses equipped with heating plants; Areas with low density of industries or houses but subjected to frequent winds and/or rainfall; Agricultural areas (*see* Note 1); Mountainous areas; and All these areas shall be situated at least 10 km to 20 km from the sea and shall not be exposed to winds directly from the sea (*see* Note 2)
II — Medium	Areas with industries not producing particularly polluting smoke and/or with average density of houses equipped with heating plants; Areas with high density of houses and/or industries but subjected to frequent winds and/or rainfall; and Areas exposed to wind from the sea but not too close to the coast (at least several kilometres distant) (*see* Note 2).
III — Heavy	Areas with high density of industries and suburbs of large cities with high density of heating plants producing pollution; and Areas close to the sea or in any case exposed to relatively strong winds from the sea (*see* Note 2).
IV — Very Heavy	Areas generally of moderate extent, subjected to conductive dusts and to industrial smoke producing particularly thick conductive deposits; Areas generally of moderate extent, very close to the coast and exposed to sea-spray or to very strong and polluting winds from the sea; and Desert areas, characterized by no rain for long periods, exposed to strong winds carrying sand and salt, and subjected to regular condensation.

NOTES

1 Use of fertilizers by spraying, or the burning of crop residues, can lead to a higher pollution level due to dispersal by wind.

2 Distances from sea coast depend on the topography of the coastal area and on the extreme wind conditions.

Annex D gives the definition of these parameters and an indication of their value.

6.2 Influence of the Position of Insulators

6.2.1 There is normaly some change in the pollution performance of insulators designed for use in the vertical position when they are used in an inclined or horizontal position. Generally, the change is for an improvement in performance, but in certain cases a reduction may result, for example, due to the cascade effect of heavy rain.

6.2.2 Unless specific data showing significantly improved performance is available, any change in performance due to position should be neglected.

NOTE — If insulators are designed for use in an inclined or horizontal position, the performance under polluted conditions can be checked by laboratory or field tests in the position for which they are designed.

6.3 Influence of the Diameter

6.3.1 Various laboratory tests appear to indicate that the pollution performance of post insulators and hollow insulators decreases with increasing average diameter.

Table 2 Creepage Distance

(*Foreword, Clauses* 5.1, 7.1, and *Table* 3)

Pollution Level	Minimum Specific Creepage Distance (mm/kV)
I — Light	16
II — Medium	20
III — Heavy	25
IV — Very heavy	31

NOTES

1 For the actual creepage distance, the specified manufacturing tolerances are applicable.

2 Ratio of the leakage distance measured between phase and earth over the rms phase-to-phase value of the highest voltage for the equipment (*see* IS 2165).

3 In very lightly polluted areas, specific creepage distances lower than 16 mm/kV can be used depending service experience. 12 mm/kV seems to be a lower limit.

4 In the case of exceptional pollution severity, a specific creepage distance of 31 mm/kV may not be adequate. Depending on service experience and/or on laboratory test results, a higher value of specific creepage distance can be used, but in some instances the practicability of washing of greasing (*see* Annex B) may have to be considered.

6.3.2 The following values for k_D are proposed, k_D being a factor to increase the creepage distance with average diameter D_m in millimetres.

Average diameter $D_m < 300$ mm : $k_D = 1$

$300 \leqslant D_m \leqslant 500$ mm : $k_D = 1{\cdot}1$

$D_m > 500$ mm : $k_D = 1{\cdot}2$

However, these values may differ according to the origin of different results (field results or laboratory tests). This factor should, therefore, be used with caution.

For a given profile, the average diameter D_m is given by:

$$D_m = \int_0^h \frac{D(l)\,dl}{h}$$

where

h is total creepage distance of the insulator; and

$D(l)$ is the value of the diameter at a creepage distance l, measured from one electrode.

The above formula may be approximated in general by the following simple relations:

a) Regular sheds $D_m = \dfrac{D_e + D_i}{2}$ (Fig. 1)

b) Alternative sheds

$$D_m = \frac{D_{e1} + D_{e2} + 2D_i}{4} \qquad \text{(Fig. 2)}$$

7 DETERMINATION OF THE CREEPAGE DISTANCE

7.1 The minimum creepage distance of an insulator situated between phase and earth is determined, according to the pollution level of the site, by the relation:

Minimum creepage distance = Minimum specific creepage distance (Table 2) × highest system voltage phase-to-phase for the equipment × k_D

where:

k_D is the correction factor due to diameter (*see* **6.3.2**).

7.1.1 If insulators are to be used between phases (phase-spacers for instance), the creepage distance should be multiplied by $\sqrt{3}$ (for a three-phase system).

8 EVALUATION OF POLLUTION SEVERITY

8.1 The application of this guide is directly related to the knowledge of the pollution severity of the site where insulators are to be installed.

8.1.1 The evaluation of the pollution severity can be made with an increasing degree of confidence:

a) Qualitatively from indications given in Table 1;

b) From information on the behaviour of insulators from lines and substations already in service on that site (*see* Annex A); and

c) From measurement *in situ*.

8.2 For measurements *in situ*, different methods are generally used. They are:

a) Volume conductivity for the pollutant collected by means of directional gauges;

b) Equivalent Salt Deposit Density on the insulator surface (ESDD method);

c) Total number of flashovers to insulator strings of various lengths;

d) Surface conductance of sample insulators; and

e) Leakage current of insulators subjected to service voltage (highest current values during subsequent time intervals, I_H).

8.2.1 The first two methods do not require expensive equipment and can be easily performed. The volume conductivity method gives no direct information by itself on the frequency and on the severity of the contamination events on a natural site. The ESDD method characterizes the pollution severity of the site. Information on wetting shall be separately obtained.

8.2.2 The accuracy of these methods depends upon the frequency of measurement. However, for the ESDD method, an automatic measuring system has been developed and therefore, pollution severity can be measured continuously, in order to find, for example, the suitable timing of washing.

8.3 The method based on total flashovers needs expensive test facilities. Reliable information can be obtained only for insulators having a length close to the actual length and flashing over at a voltage near the operating voltage.

8.4 The last two methods given in **8.2** which need a power source and special recording equipment have the advantage that the effects of pollution are continuously monitored. These techniques have been developed for assessing the pollution rate and the results, when related to test data, are used to indicate that the pollution is still at a level known to be safe for operational service or whether washing or re-greasing is required.

NOTE — For more information on these different methods *see* 'Electra' No. 64 — May 1979, Page 101 and Fig. 1 and Fig. 2.

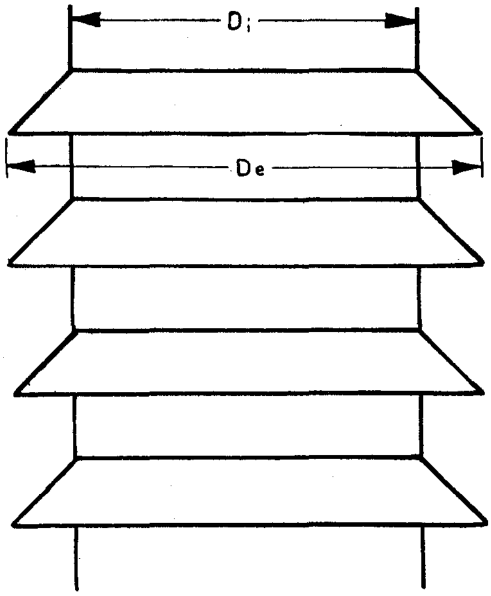


FIG. 1 REGULAR SHEDS

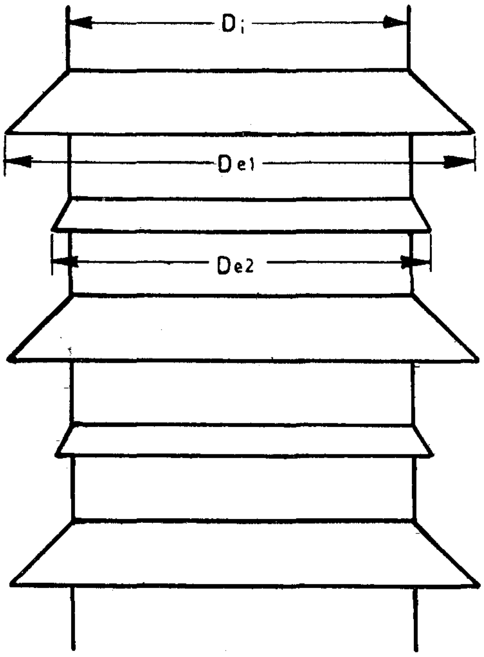


FIG. 2 ALTERNATING SHEDS

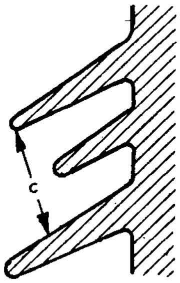


FIG. 3 MINIMUM DISTANCE *c* BETWEEN SHEDS

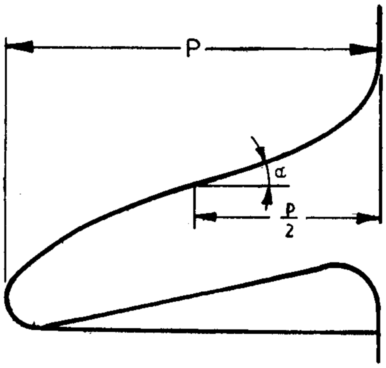
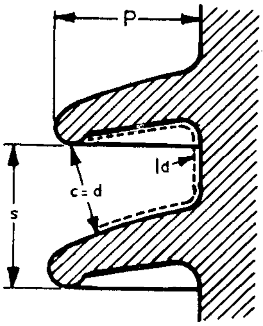
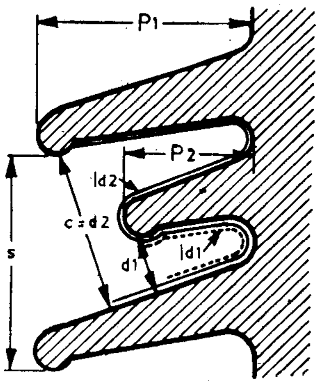


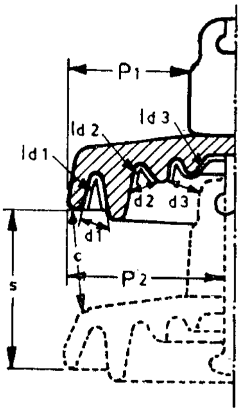
FIG. 4 INCLINATION OF SHEDS



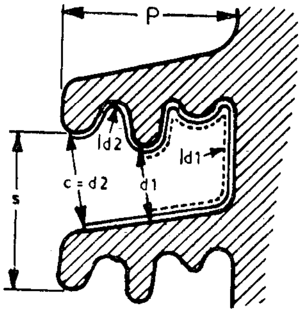
5A Normal Sheds



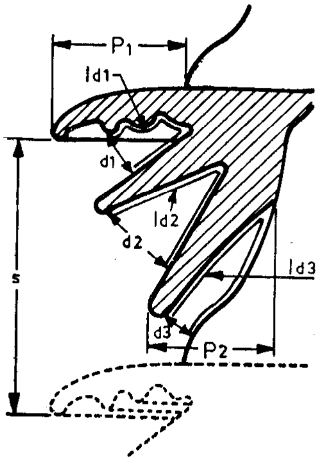
5B Alternating Sheds



5C Cap and Pin Insulator



5D Underrib Sheds



5E Pedestal Type Post Insulator

FIG. 5 PARAMETERS CHARACTERIZING INSULATOR PROFILE

ANNEX A

[*Foreword and Clause* 8.1(b)]

EXAMPLE OF A QUESTIONAIRE TO COLLECT INFORMATION ON THE BEHAVIOUR OF INSULATORS IN POLLUTED AREAS

Company……………………………………………

Indentification of project and/or location…………

……………………………………………………

Line or substation……………………………………

Person to consult for complementary information, address, telex, telephone……………………………

……………………………………………………

A-1 GENERAL INFORMATION

Nominal voltage of the system and highest voltage for equipment
Date of construction
Type of system
Maintenance (not involving changes of insulator)

For overhead line

Type of tower (sketch)
Number of circuit
Ground clearance of string
Type of insulator sets
Insulator protective fittings
Date of energizing
Cleaning — yes or no — frequency……………………
Washing — yes or no — frequency……………………
Greasing — yes or no — frequency……………………

For substations

Type of apparatus:

- Circuit-breaker
- Disconnector
- Instrument transformer
- Lightning arrester
- Bus-bar insulator

Clearance between base of insulator and ground

A-2 INFORMATION ON THE SITE

Map of areas crossed and routing of the line.
For polluted areas only, the different climatic zones crossed by the line (mark them on the map).
For substations, place, orientation and altitude.

A-3 INFORMATION OF WEATHER CONDITIONS

Type of climate : temperate, tropical, equatorial, continental…………………
Time without rainfall, in months
Annual rainfall, in millimetres
Dominant wind; direction, average speed in kilometers per hour
Dew: sometimes, often, never
Fog: sometimes, often, never

A-4 INFORMATION ON POLLUTION

For example:

- Seaborne pollution (high percentage of salt) — small amount of insoluble matter
- Saline pollution other than coastal — small amount of solids
- Sand-based pollution or ground dust (for example, desert……………)
- Industrial pollution with large amounts of solid deposits (except cement)
- Industrial pollution with large amounts of cement
- Chemical industrial pollution (gas, smoke ……………)
- Mixed pollution (indicate in this case the main components, for example, for coastal cement factories)

A-5 DATA ON INSULATION

For overhead lines

Position of string:

- Vertical (suspension)
- Horizontal (tensions)
- Angle (in degrees)
- Number of units per string
- Type of insulator (drawing)
- Spacing
- Creepage distance of unit

Indicate any modification in the initial insulation

For substations

Type of insulator:

- Post insulator (solid core)
- Pedestal insulator
- Bushing
- Hollow insulator

Profile and spacing of shed (give details)
Total creepage distance

A-6 SCHEDULE OF INCIDENTS

Date and time
Situation of the tower (for line) and place of apparatus in substation
Critical meteorological conditions at the moment of incidents

- Relative humidity
- Rain
- Drizzle
- Fog
- Temperature
- Storm
- Wind (direction, speed)
- Time between last rainfall and incident
- Other

Type of incident

- Flashover
- Heavy corrosion of metal parts
- Punctured dielectric
- Visible damage to dielectric
- Erosion or tracking

For a string of insulators place of damaged units in the string
Comments of the incident indicating any special circumstances.

ANNEX B

(*Foreword* and *Table* 2 *Note* 4)

GREASING AND WASHING

B-1 In exceptional cases, pollution problems cannot be solved economically by a good choice of the insulator. For instance, in areas having very severe contamination or low annual rainfall, insulator maintenance may be required. This can also occur when the environment of an already built substation (or line) changes due to new polluting industries.

Maintenance normally takes one or more of the following forms:

a) Periodic hand wiping on de-energized installation of dry cleaning either energized or de-energized;

b) Periodic coating with grease compounds; and

c) Periodic washing, either energized or de-energized.

B-1.1 Greasing

Grease compounds used for coating insulators are mainly silicone products or hydrocarbons. The thickness of the applied layer of grease depends on the type of grease and on the degree of pollution; generally, for the silicone based compounds it is about 1 mm and for hydrocarbon compounds can reach some millimetres.

This type of application requires regular maintenance for removing the grease and recoating and is expensive. It should be pointed out that the greased insulation loss most of their properties of self-cleaning through the rain or through the wind and that under certain conditions of heavy pollution the grease can damage the ceramic or the glass.

The frequency of cleaning and regreasing ranges from some months to some years, depending upon the degree of contamination and the weather conditions. An optimization of these operations shall be reached by a check of the conditions of the grease, taking into account the accumulation rate of the pollution content in the grease and the ageing of the grease itself.

B-1.2 Washing

There are two main methods for the washing of insulators to remove pollution:

a) By fixed sprays, and

b) By using a manually controlled portable jet.

The frequency of washing should be such as to avoid significant accumulation of pollution. Thus the objective is to keep the insullators in as clean a condition as possible.

Insulator washing with fixed, automatic sprays is an effective and reliable method of combating pollution, particularly when the deposit rate is high. This technique has high capital cost and low running cost.

Portable jut washing equipment operators under the direct control of suitably trained persons and can be used at more than one site. It has low capital cost and high running cost. Some safety precautions are necessary.

Both systems require:

a) A stored supply of water of adequate capacity and suitable low condutivity. Town mains water may be suitable for washing in some cases;

b) Special nozzles to ensure that the wash water breaks into droplets; and

c) Precautions to reduce the risk of water being blown onto unwashed insulators by strong winds.

Where the pollution deposit rate is high, a pollution detector is desirable to initiate fixed washing or to call for a manual wash.

The effectiveness of washing is dependent on the design of the insulators particularly the shape and spacing of sheds. In general, insulators oil good pollution performance will wash well, particularly if the shed profile has good aerodynamic qualities.

NOTE — For lightning arresters with internal gaps, special care should be taken to avoid flashover or explosion during washing.

ANNEX C

(*Foreword*)

RELATION BETWEEN POLLUTION LEVELS AND ARTIFICIAL POLLUTION TESTS

C-1 These relations between pollution levels and artificial pollution tests on particular cap and pin and long-rod insulators are given only as examples, and cannot be used for type tests on line insulators. Neither should the given withstand severity be interpreted as a specification for post insulators and hollow insulators.

C-1.1 Table 3 gives for each pollution level the range of values which were obtained in some artificial pollution tests performed according to the test procedures described in IS 8704 : 1978.

NOTE — The test procedures will be modified in the next revision of IS 8704 : 1978, especially those of the solid-layer methods. This may lead to values different from those given here.

Table 3 Severity Withstand Voltage

(*Annex* C-1.1)

Specific Creepage Distance (*see* Col 2, Table 2)	**Artificial Pollution Tests Severity Withstand Values at the Phase-to-Earth Voltage**		
	Salt Fog Method	Solid-Layer Methods	
(mm/kV)	(kg/m^3)	SDD*	Layer Conductivity
		(mg/cm^2)	(μS)
16	5 to 14	0·03 to 0·06	15 to 20
20	14 to 40	0·10 to 0·20	24 to 35
25	40 to 112	0·30 to 0·60	36
31	> 160	—	—

*SDD = Salt Deposit Density.

ANNEX D

(*Clauses* 6.0.2 *and* 6.1.1)

PARAMETERS CHARACTERIZING THE INSULATOR PROFILE

D-0 These parameters are related to insulators installed in a vertical position. For other positions, *see* **6.2**.

D-1 MINIMUM DISTANCE *c* BETWEEN SHEDS

D-1.1 *c* is the minimum distance between adjacent sheds of the same diameter, measured by drawing a perpendicular from the lowest point of the outer rib of the upper shed to the shed below of the same diameter (*see* Fig. 3).

This distance is important in rainfall conditions to avoid bridging between two successive sheds. According to present knowledge, a value of *c* in the order of 30 mm or more fulfils this requirement. For insulators having an overall length less than or equal to 550 mm, or for insulators with small shed overhang *p* (*see* **D-2**) ($P \leqslant 40$ mm) a value of *c* in the order of 20 mm is acceptable.

NOTES

1 *c* is not applicable to pedestal-type post and pin-type insulators.

2 For insulators with alternate sheds, *see* **D-4**.

D-2 RATIO *s/p* BETWEEN SPACING AND SHED OVERHANG

D-2.1 The ratio *s/p* describes the limitation on providing arbitrarily too high a leakage distance by either over dimensioning the shed overhang *p* or by unjustifiably increase the number of sheds. The ratio is important for self-cleaning properties of insulators.

s/p should be equal to or greater than 0·8. Field experience shows that this value can be reduced to 0·65 in the case of plain sheds (without ribs).

s is the vertical distance between two similar points of successive sheds (spacing).

p is the maximum shed overhang (that is, p in Fig. 5a and Fig. 5d, p_1 in Fig. 5b and p_2 in Fig. 5c).

D-3 RATIO l_a/d BETWEEN CREEPAGE DISTANCE AND CLEARANCE

D-3.1 The ratio l_a/d describes the use of the creepage distance in order to avoid local short-circuiting and should be lower than 5. This ratio should be checked for the 'worst case' on any section, for example, of the underside of an anti-fog insulator profile.

d is the straight air distance measured between two points situated on the insulating part or between any point located on the insulating part and the other or a metal part.

l_a is the part of the creepage path measured between the above two points.

D-4 ALTERNATIVE SHEDS (*see* Fig. 5b)

D-4.1 The difference ($p_1 - p_2$) between two consecutive shed overhangs is important in rain conditions to avoid bridging between them.

p_1 is the shed overhang of the larger shed; and

p_2 is the shed overhang of the smaller shed.

This difference ($p_1 - p_2$) should be in general greater than or equal to 15 mm.

D-5 INCLINATION SHEDS

D-5.1 The inclination of sheds is important for the self-cleaning properties. For the top of the shed, the minimum inclination of the shed (°C) should be greater than 5° (*see* Fig. 4).

No minimum angle in specified for the bottom part of the shed. However, if the bottom part is without ribs, a minimum inclination of 2° is advisable.

D-6 PARAMETERS CHARACTERIZING THE ENTIRE INSULATOR

D-6.1 The insulators, as far as their performance under pollution is concerned can be designed in different manners. When the pollution severity increases, a solution to satisfy the specific creepage concept in obviously to increase the length of the insulator while keeping the same shed profile.

NOTE — When clean string insulator units are added to or replaced in a polluted insulator string, the complete string shall be cleaned before the line is re-energized.

However, the above solution cannot be applied or may not be economical when the pollution severity is too high. Therefore, it is possible to design insulators having different profiles suitable for the specified pollution severity.

The different parameters given above characterize local parts of a profile, but it is still necessary to characterize the entire insulator by the creepage factor (CF) and by the profile factor (PF). These two factors depend on the pollution severity.

CF has a theoretical and scientific meaning, while PF is an empirical quantity derived from experience. CF can be used to characterize the profile of all types of insulators, whereas PF is not applicable to cap and pin insulators (*see* Fig. 5c) and pedestal post insulators (*see* Fig. 5e).

D-6.2 Creepage Factor (CF) (*see* Fig. 5)

The creepage factor, CF is equal to $\left(\frac{l_t}{S_t} \right)$

Where:

l_t is the total creepage distance of an insulator; and

S_t is the arcing distance, which is the shortest distance in air, outside the insulator, not considering arcing horns, between the metallic parts to which the voltage is normally applied.

It is advisable to keep:

CF $\leqslant$ 3·50 for pollution levels I and II, and

CF $\leqslant$ 4 for pollution levels III and IV.

NOTE — If an insulator has a profile with a CF higher than the limit value recommended, the insulator profile may be used if experience in operation, or a laboratory test reproducing operation conditions, permits the assumption of good performance.

D-6.3 Profile Factor (PF)

The PF is defined as the ratio of the simplified leakage distance to the actual insulating creepage distance measured between the two points which define the spacing S.

The simplified leakage distance is the sum of:

$2p+s$ for insulators in Fig. 5a and Fig. 5d;

$2p_1+2p_2+s$ for insulators in Fig. 5b; and

p, p_1, p_2 and s having the definitions given above and shown in Fig. 5a to Fig. 5e.

Thus, PF is equal to:

$\frac{2p+s}{1}$ for insulators in Fig. 5a and Fig. 5d; and

$\frac{2p_1+2p_2+s}{1}$ for insulators in Fig. 5b.

l being the creepage distance of the insulated leakage path measured between the two points which define *s*.

It is advisable to keep:

PF above 0·8 for pollution levels I and II; and

PF above 0·7 for pollution levels III and IV.

NOTE — If an insulator has a profile with a PF lower than the limit value recommended, the insulator profile may be used if, experience in operation, or a laboratory test reproducing operation conditions, permits assumption of good performance.

General NOTE — The protected part of the profile (protected creepage distance) should not be specified as a parameter characterizing a shed profile.

In effect, no general rules can be quantified because the degree to which a shed profile is *open* or *protected* depends mainly on:

a) The different site conditions of contamination,

b) The prevailing self-cleaning conditions, and

c) The position of the insulator (angle of inclination).

The example, for insulators used in vertical position in an area exposed to salt storms and frequent and intensive rain, protected (either profiles with underribs or plain sheds of steep inclination) have proved to be useful.

On the other hand, for insulators used in an area with rare or low intensity rain or airborne contaminants, *open* (or aerodynamic) profiles seem to show good performance. In such cases, the creepage distance of underribs can be put out of action by being filled with contaminants.

Standard Mark

The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The Standard Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well defined system of inspection, testing and quality control which is devised and supervised by BIS and operated by the producer. Standard marked products are also continuously checked by BIS for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act, 1986* to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in the course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Revision of Indian Standards

Indian Standards are reviewed periodically and revised, when necessary and amendments, if any, are issued from time to time. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition. Comments on this Indian Standard may be sent to BIS giving the following reference :

Doc : No ETD 06 (3107)

Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 331 01 31, 331 13 75

Telegrams : Manaksanstha
(Common to all Offices)

Regional Offices:	Telephone
Central : Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	331 01 31 331 13 75
Eastern : 1/14 C. I. T. Scheme VII M, V. I. P. Road, Maniktola CALCUTTA 700054	37 86 62
Northern : SCO 445-446, Sector 35-C, CHANDIGARH 160036	53 38 43
Southern : C. I. T. Campus, IV Cross Road, MADRAS 600113	235 02 16
Western : Manakalaya, E9 MIDC, Marol, Andheri (East) BOMBAY 400093	6 32 92 95

Branches : AHMADABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. PATNA. SRINAGAR. THIRUVANANTHAPURAM.

Printed at Printrade, New Delhi, India